

A 610-MHz Galactic Plane Pulsar Search with the Giant Meterwave Radio Telescope

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Abstract. We report on the discovery of three new pulsars in the first blind survey of the north Galactic plane ($45^\circ < l < 135^\circ$; $|b| < 1^\circ$) with the Giant Meterwave Radio telescope (GMRT) at an intermediate frequency of 610 MHz. The timing parameters, obtained in follow up observations with the Lovell Telescope at Jodrell Bank Observatory and the GMRT, are presented.

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INTRODUCTION

Most pulsar surveys have been carried out with single dish telescopes where there is a trade-off between the collecting area and the beam-width, and consequently the rate of the survey. In a multi-element telescope such as the Giant Meterwave Radio Telescope (GMRT), a large number of smaller antennas can be combined to provide a high sensitivity and yet retain a relatively large beam-width. In this paper, we report on the discovery of three new pulsars in the first blind survey of the north Galactic plane ($45^\circ < l < 135^\circ$; $|b| < 1^\circ$) with the GMRT at an intermediate frequency of 610 MHz, which represents the best trade-off between the increased flux density at low frequency for pulsars, interstellar scattering and dispersion and beam-width. The GMRT's multi-element nature was also exploited to determine the positions of the pulsars to an accuracy of 5 arcminutes and this technique is also described.

OBSERVATIONS

The survey consists of 300 fields. The observations were conducted using typically 20 to 25 45-m GMRT antennas combined in an incoherent array mode at a frequency of 610 MHz. Each $43' \times 43'$ field in this mode was observed for 35 minutes with a bandwidth of 16 MHz with 256 spectral channel across the band. The data in each channel were acquired with 16-bit precision every 256 μ s after summing the two polarizations and recorded to SDLT tapes for off-line processing. The 8 sigma threshold for detecting a pulsed signal with a duty cycle of 10

percent for the configuration used is 0.5 mJy, which is comparable to the sensitivity of the Parkes multibeam survey (Manchester et al. 2001).

CANDIDATE LOCALIZATION

The pulsar candidates were confirmed in the follow-up observations with the GMRT using the same observing configuration as used for the survey. The pulsar position was localized exploiting the multi-element nature of the GMRT. The range of baselines available for the GMRT antennas allows forming beams with a range of beam-widths when appropriate antennas are combined as a phased array to form an equivalent single dish with similar sensitivity as a 20 antenna incoherent array. Three combinations of the nearest 3, 5 and 6 antennas respectively were used in this mode to observe the candidate field and four fields offset in Right Ascension and Declination by half of Full Width at Half Maximum (FWHM) for the respective array. The respective FWHM in the above configurations were 20, 10 and 5 arcminutes. The detected signal-to-noise ratio of each new pulsar in these gridding observations was used to refine the position successively to 5 arcminutes accuracy. The refined position was used for timing observations at 1420 MHz with the Lovell Telescope at Jodrell Bank Observatory. This allowed follow-up confirmation and timing studies with high sensitivity with the Lovell Telescope and a rapid determination of pulsar parameters.

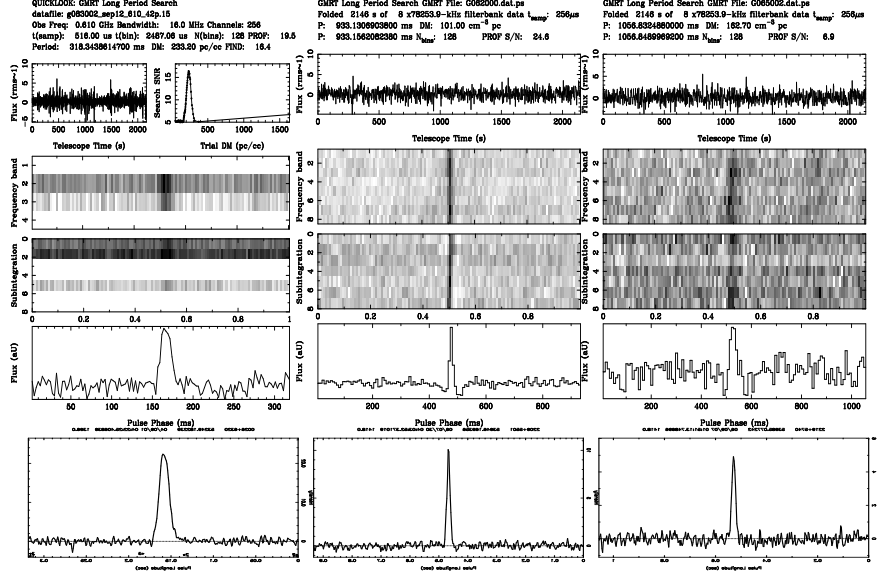


FIGURE 1. Discovery plots for the three new pulsars, PSRs J0026+6320, J2208+5500 and J2218+5729 (left to right). The top plot in each panel shows the root mean square power as a function of time. The second and third plot in each panel show intensity as a function of subband and pulse phase and sub-integration and pulse phase respectively. The bottom two plots show average profile at 610 MHz observed with the GMRT and at 1420 MHz observed with the Lovell telescope respectively.

TABLE 1. Timing Parameters of the new pulsars

NAME	l_{field} (deg)	b_{field} (deg)	l (deg)	b (deg)	DM (pc/cm ³)	P (s)	Pdot (10 ⁻¹⁵)
J0026+6320	120.15	0.78	120.18	0.59	230.31	0.318357728337(2)	0.1500(2)
J2208+5500	101.25	-0.78	100.94	-0.75	101.03	0.93316093521(1)	6.988(5)
J2218+5729	103.95	0.78	103.52	0.49	162.75	1.056844	

ANALYSIS

The data were analyzed using the pulsar searching package SIGPROC (<http://sigproc.sourceforge.net>). The data were dedispersed using 145 trial dispersion measures (DM) ranging from 0 to 2000 pc cm⁻³, with spacing determined by the dispersion smearing across each individual frequency channel. Periodicities were searched for using both a Fast Fourier Transform and a Fast Folding Algorithm. Known interference frequencies were eliminated and new pulsar candidates were identified through inspection of diagnostic plots. A single-pulse search was also performed; due to the large amount of impulsive interference in our data, the results of this search are still under analysis.

RESULTS

Out of 300 fields observed so far, we have processed 214 fields, covering about 100 square degrees of sky and redetected 11 known pulsars. Three new pulsars,

PSRs J0026+6320, J2208+5500 and J2218+5729, have been discovered so far. The discovery plots of the new pulsars alongwith their average profiles observed at the GMRT and Lovell Telescope are shown in Figure 1. The observed parameters of the new pulsars are given in Table 1.

The entire data is being reprocessed with better radio frequency interference excision to look for sources similar to recently reported Rotating Radio Transient (McLaughlin et al. 2006), for which the parameters of this survey are particularly suitable. We are also extending the survey area to ($45^\circ < l < 165^\circ$; $|b| < 3^\circ$) and plan to complete these observations in the coming months.

REFERENCES

1. R. N. Manchester et al., *MNRAS*, **328**, 17–35(2001).
2. M. A. McLaughlin et al., *Nature* **439**, 817–820(2006).